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Summary of the 1990 Coho Salmon Smolt Trapping Operations on the Lachmach River, British Columbia

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ABSTRACT

Davies, D. L. W. 1991. Summary of the 1990 coho salmon smolt trapping operations on the Lachmach River, British Columbia. Can. Data Rep. Fish. Aquat. Sci. 832: 53 p.

A permanent welded aluminum smolt fence was used to capture smolts at the mouth of the Lachmach River, east of Prince Rupert, British Columbia, between April 12 and June 6, 1990. A total of 25,860 coho smolts was captured. Of these, 24,639 smolts were coded wire tagged and adipose fin clipped. Totals of 1,189 rainbow trout, 1,964 Dolly Varden, 1,387 sculpins and 9 cutthroat trout were also captured.

RÉSUMÉ

Davies, D. L. W. 1991. Summary of the 1990 coho salmon smolt trapping operations on the Lachmach River, British Columbia. Can. Data Rep. Fish. Aquat. Sci. 832: 53 p.

Une barrière permanente en aluminium soudé a été utilisée pour capturer des smolts à l'embourchure de la rivière Lachmach, à l'est de Prince Rupert (Colombie-Britannique), entre le 12 avril et le 6 juin 1990. Un total de 25 860 saumons cohos ont été capturés. De ce nombre, 24 639 smolts one été étiquetés au moyen de fil de fer codé et leur nageoire adipeuse a été coupée. On a également capturé un total de 1 189 truites arc-en-ciel, 1 964 Dolly Varden, 1 387 chabots et neuf truites fardées.

INTRODUCTION

The Lachmach River Project is part of the Coho Salmon Research Program which was initiated in response to the Canada-U.S. Pacific Salmon Treaty. The Program obtains information on the biology and productivity of coho salmon (Oncorhynchus kisutch) stocks in British Columbia. The Lachmach River Project was set up in the spring of 1987 to obtain information on northern B.C. coho salmon stocks. Data have been collected each spring beginning in 1987, (Table 1) (Finnegan et al. 1990 ; Finnegan 1990 ; Davies 1991).

The Lachmach River is located 23 km. east of Prince Rupert, B.C., at the head of Work Channel (Fig. 1). This report presents data from fence operations, coho smolt trapping and sampling, and coded wire tagging operations conducted in the spring of 1990.

METHODS

The permanent aluminum smolt fence used on the Lachmach River in 1990 was described in detail in the 1988 spring data report (Finnegan 1990). The only change to the fence in 1990 was the modification of the upstream trap to improve the capture of migrating adult steelhead trout (Oncorhynchus mykiss).

A temporary smolt fence was installed on the upper Lachmach River immediately downstream of the 5000 m pond (Fig. 2). This fence was also described in detail in both the 1988 and 1989 data reports (Finnegan 1990 ; Davies 1991).

A 2x3 inclined plane trap (Conlin and Tutty 1979) was installed 50 m upstream of the main fence to collect data on fish that were small enough to swim through the fence such as coho and pink fry (Oncorhynchus gorbuscha). The trap was tethered by a 1/4 inch cable to another 1/4 inch cable spanning the river. Each evening, the trap was pushed out into the main flow of the river into fishing position and left to fish overnight. Every morning the trap was emptied of fish and pulled to the side of the river out of fishing position for the remainder of the day.

The fish captured in the trap were counted separately and then pooled with the fish caught at the main fence, and were sampled and tagged using the same method as the fence caught fish.

Every day at the main fence, fish were sorted by species, enumerated, sampled and checked for marks. Random samples were obtained by two different methods. Method 1 involved rapidly moving a small dipnet through the fish in the trap box and scooping up a netful of fish until approximately 100 fish or about 10% of the total catch was removed. Method 2 involved taking every third dipnet of fish and putting them in a separate bucket until 100 fish

were obtained. Samples were anaesthetized with 2-phenoxyethanol and measured for fork length and weight. Fork lengths were measured on a smolt board to an accuracy of 0.5 mm. Weights were measured on an Ohaus Port-O-Gram balance to an accuracy of 0.05 g. Selection for scale sampling for age analysis was done by selecting smolts from 5 mm size groups from 40 mm to 170 mm and attempting to get 14 scale samples from each group throughout the smolt run. Fin clips, brands and any unusual condition (ie. deformities, injuries, etc.) were recorded. All clipped, branded and unusually large or small fish (whether within the random sample or not) were measured for length and weight and had scales taken.

At the 5000 m fence, all fish were counted, checked for marks and measured to an accuracy of 0.5 mm. All coho juveniles were given an upper caudal fin clip.

All mortalities were recorded by species, sexed, and measured for fork length and wet weight. Scales, otoliths and fin rays were taken from some of the dead fish for age analysis.

All coho smolts captured at the main fence were anaesthetized with 2-phenoxyethanol, adipose fin clipped and coded wire tagged with standard tags (Northwest Marine Technologies, Shaw Island, WA. ; Mk II Tagging Unit). Coho smolts were divided into two groups, larger and smaller than 85.5 mm, and were tagged with different tag codes. This size was selected as the best length to separate age 1.0 and 2.0 smolts based on age-length analysis in 1989 (Davies, 1990). Fish smaller than 60 mm were too small to tag and were released untagged and unclipped. Tag codes for large coho were 08/26/30, 08/27/19, 08/27/18. Tag codes for small coho were 08/26/34 and 08/27/07.

After each day of tagging, a maximum sample of 100 tagged fish from each size group was held overnight. The next day these fish were put through the metal detector of the quality control device to see which fish had lost their tags. All fish that had lost their tags were retagged before release.

Two groups of one hundred smolts were marked and released 50 m upstream of the main fence to assess the fence's capture efficiency. Recaptures of marked fish were recorded at the main fence and the recapture rate was used as an indication of fence efficiency. The first group consisted of 10 small and 90 large CWT smolts that were upper caudal clipped and released on May 3. The second group consisted of 50 CWT smolts of each size group which were upper and lower caudal clipped and were released on May 14.

Adult steelhead were counted through the fence either by dipnetting them from the trap or from behind the fence nosecones and passing them over the top of the fence or by opening a gap in the fence panel and letting them swim through.

Daily records were kept of cloud cover, precipitation, water temperature, air temperature and water level. Observations were generally taken at 0800.

RESULTS

MAIN FENCE

Coho

The Lachmach River smolt fence was in almost continuous operation for 55 days in 1990. High water conditions on May 6 forced the field staff to remove the fence panels at 0945 hrs on May 6. They were not replaced until 1330 hrs on May 7. Totals of 25,860 smolts were caught during fence operations (Table 2). 24,639 smolts, or 95.3% of the total run were coded wire tagged and released alive, while 504 were mortalities. Smolts released untagged totalled 717 and included fish too small to be tagged (fish less than 65 mm were too small to fit in the smallest head mold for the tagging machine), fish that escaped from the tagging shed before being tagged and any moribund or injured fish. Large smolts (larger than 85.5 mm) comprised 84% of the total smolt run (Table 3). Coho smolts that were sampled totalled 3,995 or 15.7% of the total run (Table 4). The run peaked on May 15 with a secondary peak on May 21 (Fig 3).

An unknown number of smolts passed the fence uncounted during the flood conditions of May 6-7. If the smolt numbers on May 6 (448) and May 8 (503) are averaged, then an estimate of 475 smolts passing the fence on May 7 can be obtained. After the water receded on May 7, 106 smolts were found in the trap boxes. Of the estimate of 475 smolts migrating on May 7, 106 were captured and the remaining 369 smolts can be assumed to have passed the fence uncounted (Table 2).

The results of the fence efficiency tests indicated that the recapture rate for early migrants was 82% and for peak migrants was 94% (Table 5). These results indicate a high efficiency if one takes into account the fact that marked fish released upstream of the fence do not necessarily migrate downstream during fence operations and that released fish may experience some handling and stress related mortality. Some of the early test fish may have passed the fence undetected during the freshet on May 6 - 7 when the panels were removed.

Tag retention tests indicated a 1% loss of tags for both large and small smolts. If this loss rate is applied to the total numbers of fish tagged, then 3926 small smolts and 20,466 large smolts would be expected to have retained their tags after 24 hours. Tag retention tests over 48 hours were conducted in

previous years and indicated no additional tag loss.

Small smolts were tagged with 2 tag codes; 08/26/34 until May 14 and 08/27/07 from May 15 to the end of the study (Table 6). Large smolts were tagged with 3 tag codes; 08/26/30 until May 8, 08/27/19 from May 8 until May 19 and 08/27/18 after May 19.

Selection of smolts for sampling was conducted using two different methods. Method 1 involved rapidly moving a dipnet through a large bucket of fish and selecting the first 100 fish scooped. Method 2 involved selecting fish from every third dipnet until 100 smolts were obtained. Sampling results from each method were kept separate. Results from the two sampling methods are shown in Table 4 and the length frequencies are compared in Figure 4. The results show that Method 1 and Method 2 produced very similar results. Average lengths and weights using Method 1 were 93.1 mm (SE = 0.22, N = 2,586) and 7.54 g (SE = 0.07,N = 2,057). Average lengths and weights using Method 2 were 92.9 mm (SE = 0.23, N = 1,409) and 7.44 g (SE = 0.09,N = 1,326). The overall average length was 93.1 mm and the average weight was 7.50 g. The length frequency graphs are very similar except for the difference in total number sampled with each sampling method (Figure 4).

A number of smolts with mutilation type marks were recaptured at the main fence (Table 7). Most of the marked fish recaptured were marked in the late summer and early fall of 1989 as part of a study to determine juvenile coho movements within the system. The largest number of marked fish recaptured at the main fence were right ventral clipped fish from the 5000 m ponds, marked in the summer of 1989. As none of these fish were captured at the 5000 m fence during the present study period, it is likely that these fish moved out of the 5000 m ponds and into other areas of the system in the fall or winter before the 5000 m fence was installed on April 21. A total of 109 left maxillary clipped fish were marked in 1989 at the main fence after tagging ended on June 5 and 13 were recovered in 1990 at the main fence. These 13 fish probably stayed in the estuary for the entire year. The upper caudal fin clipped fish were marked at the 5000 m fence during the 1990 study period and only 133 were recovered at the main fence out of a total of 259 marked.

Twenty one adipose clipped smolts were captured at the main fence in 1990. Fourteen of these smolts had a coded wire tag. Coded wire tags were recovered and analyzed from the heads of five of these smolts. Four of the smolts were from 1990 tag groups (3 from 08/27/19 and 1 from 08/27/18) and one was from a 1989 tag group (08/26/47). It is unknown how the 1990 marked smolts were captured in the trap boxes. It is possible that they were able to swim upstream through the fence. The 1989 tagged smolt could have swum upstream of the fence prior to fence installation on April 13.

Coho smolt mortalities totalled 502 during the study period.

These consisted of 337 mortalities found in the trap boxes, 85 found dead after the 24 hour tag retention tests, 61 killed during the tagging process, and 19 killed to observe tag placement. Most of the mortalities had scales, fins and otoliths taken from them for age analysis.

A total of 337 scale samples and 79 fin and otolith samples were taken from coho smolts for age analysis. Of these 44 (13.0%) could not be aged due to scale regeneration or poor samples, 95 (28.2%) were analyzed as age 1.0, 189 (56.1%) as age 2.0 and 9 (2.67%) as age 3.0 (Table 8). Difficulties arose with age determination due to the uncertainty of what constituted an annulus with some of the scales from fish with lengths near the upper and lower size limits for each age, (S. Maclellan, P.B.S. Scale Lab, pers. comm.). Comparisons of the three aging methods showed that there was good agreement between all structures (Table 9). There is a slight indication that when there is disagreement between structures that the otolith ages are greater than both fin and scale ages. Age compositions estimated from scales are unlikely to be in error except for age 3.0 fish which may be fewer than estimated.

The mean lengths of age 1.0, 2.0 and 3.0 smolts were 77.0mm, 107.1mm and 123.1mm respectively. The length frequency histogram shows that the lengths of age 1.0 and age 2.0 smolts overlap between 75 and 100 mm. (Fig. 5).

An estimate of the age composition of the migrating smolts was obtained by first calculating the proportion of each age within 1 mm length classes. Then each proportion was multiplied by the total number of smolts within each class to get the number of smolts by age in each length class. The numbers were then summed by age over all to obtain the numbers of smolts by age. These results showed that 7,525 (29.1%) were age 1.0, 18,102 (70.0%) were age 2.0 and 34 (0.9%) were age 3.0.

Other Species

Totals of 1,189 rainbow/steelhead (O. mykiss) trout juveniles, 1,964 Dolly Varden (Salvelinus malma) juveniles, 1,387 cottids (Cottus sp.), 9 cutthroat trout (O. clarki) juveniles, 20 coho fry and 11 pink (O. gorbuscha) fry were captured moving downstream (Table 10). Coho and pink fry were able to swim through the fence panel screen mesh and therefore were only occasionally caught in the trap boxes.

Numbers of trout juveniles migrating downstream were increasing when the fence was pulled out while migrating Dolly Varden juveniles peaked in mid May (Fig. 6). Both cottid and upstream migrating adult steelhead numbers appeared to peak in early May. Steelhead kelt numbers were still high when the the

fence was taken out.

Tables 11 and 12 show the average fork lengths and wet weights of fish other than coho smolts. Length frequencies for rainbow trout, Dolly Varden and cottids are presented in Figures 7, 8 and 9 respectively.

We counted 334 adult steelhead passing the fence moving upstream and 93 kelts going downstream. The numbers of steelhead moving upstream is only a minimum number as there were probably more fish that passed the fence without being observed. When there were many steelhead observed holding below the fence, a few panels were lifted to allow free steelhead passage. During these periods attempts were made to count as many steelhead as possible, but the demands of smolt sampling and tagging precluded a complete count. Adult steelhead could also have passed the fence unobserved before the fence was installed on April 13, during the flood event on May 6/7 and after the fence was taken out on June 6. The downstream steelhead kelt number is a minimum also as some kelts could have moved after the fence was taken out. On the evening of June 3 many kelts were observed holding upstream of the fence and a small amount of rain had raised the river level slightly. Three panels were lifted and 90 kelts were counted past the fence in a 2 hour period.

INCLINED PLANE TRAP

Fish numbers caught in the 2x3 trap are presented in Table 13. The trap was fished intermittently on 31 nights whenever time and manpower permitted. When the trap was fished, the coho smolt catches were weakly correlated ($r = 0.75$) with smolt catches at the main fence (Fig. 10). The effectiveness of inclined plane traps is known to depend on variables such as fishing position, water height, and water clarity.

Pink fry appeared to be either at their peak or past their peak when the trap was installed on April 11. Coho fry started appearing on May 21 and were still showing up when the trap was pulled out on June 8.

5000 M FENCE

The 5000 m fence was continuously fishing for 47 days from April 21 to June 7 except for a period of about 30 hours during the flood event of May 6/7 when water topped the panels and lifted the breakaway panels. Totals of 259 coho smolts, 3 rainbow/steelhead juveniles, 2 Dolly Varden juveniles, and 2 cutthroat trout juveniles were caught (Table 14). All of the coho smolts received an upper caudal clip and were released.

ENVIRONMENTAL DATA

Precipitation was generally low during the study period with the exception of one peak on May 6 and 7 when 90 mm of rain fell (Fig. 11). Total precipitation for the study period was 230 mm. Maximum and minimum air temperatures varied from a low of -2.5 deg. C on Apr. 30 to a high of 23 deg. C. on May 28 (Figure 12). On May 30 the min.-max thermometer ceased operating and spot temperatures were taken using a standard thermometer. Water temperatures gradually increased from a minimum of 4 deg. C to a maximum of 12 deg. C. (Figure 13).

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Table 1. Historical summary of fish capture and tagging during the spring at the Lachmach River.

year	fence type	coho smolts total	coho smolts cwt'ed	other species rbt	d.V.	cottids	stlhd	cutt	coho fry
1987	temp.	1,909	1,790	5	13	97	10		17
1988	perm.	9,983	9,192	103	351	175		4	
1989	perm.	21,410	19,482	1,176	1,592	767	294	4	
1990	perm.	25,860	24,639	1,189	1,964	1,387	334	9	52

Note In 1987, a temporary, wooden smolt fence was used which frequently washed out resulting in an incomplete count of the number of migrating fish.

In 1988, a permanent, aluminum fence was installed, but it is believed that it was not completely fish tight resulting in a low number of migrating fish.

In 1989 and 1990, the same permanent fence was used and we believe that the numbers of fish captured accurately reflect the true numbers of fish migrating.

Cwt'ed = coded wire tagged; temp. = Temporary;
perm. = Permanent; rbt = rainbow/steelhead trout juvenile;
D.v. = Dolly varden; stlhd = steelhead;
cutt = cutthroat trout juveniles

Table 2. Daily captures and coded wire tagging summaries of coho smolts from the main fence on the Lachmach River, 1990.

date	total smolts through the fence	morts.	total smolts released untagged [a]	total smolts released tagged
Apr. 13	9	0	9	0
Apr. 14	7	1	6	0
Apr. 15	7	0	7	0
Apr. 16	10	1	9	0
Apr. 17	27	1	26	0
Apr. 18	19	9	0	10
Apr. 19	26	2	0	24
Apr. 20	22	2	0	20
Apr. 21	25	0	0	25
Apr. 22	50	1	0	49
Apr. 23	24	2	0	22
Apr. 24	53	5	0	48
Apr. 25	35	2	0	33
Apr. 26	34	0	1	33
Apr. 27	26	1	1	24
Apr. 28	30	0	0	30
Apr. 29	18	2	0	16
Apr. 30	82	6	0	76
May 1	37	7	0	30
May 2	88	3	0	85
May 3	158	6	0	152
May 4	376	14	0	362
May 5	406	12	8	386
May 6	448	34	0	414
May 7	106(369)[b]	3	1(369)	102
May 8	503	31	0	472
May 9	562	11	0	551
May 10	539	10	4	525
May 11	469	13	1	455
May 12	679	20	5	654
May 13	1,253	49	9	1,195
May 14	1,663	16	11	1,636
May 15	2,464	15	14	2,435
May 16	2,227	9	14	2,204
May 17	1,538	9	8	1,521
May 18	888	12	7	869
May 19	593	14	11	568
May 20	1,539	12	8	1,519
May 21	2,274	27	27	2,220
May 22	1,995	22	30	1,943
May 23	901	11	19	871
May 24	541	8	13	520
May 25	461	11	10	440
May 26	537	12	10	515

Table 2. (cont.)

date	total smolts captured	mortalities	total smolts released untagged	total smolts released tagged
May 27	489	8	16	465
May 28	630	24	33	573
May 29	251	13	10	228
May 30	120	3	5	112
May 31	72	4	3	65
June 1	32	0	2	30
June 2	40	0	1	39
June 3	40	24	5	11
June 4	37	0	4	33
June 5	20	2	0	18
June 6	11	0	0	11
Totals	25,860	504	717	24,639

[a] Includes fish that were too small to tag (ie. <65mm), fish that escaped from the tagging shed before being tagged and any moribund or injured fish.

[b] 106 smolts were captured in the trap boxes and 369 smolts were estimated to have passed the fence uncounted. This estimate is included in the total.

Table 3. Daily coded wire tagging summary

date	No. tagged and released			% tag retention	
	small	large	total	small	large
Apr. 18	4	6	10	100	100
Apr. 19	12	12	24	92	92
Apr. 20	8	12	20	90	100
Apr. 21	9	16	25	89	75
Apr. 22	21	28	49	95	100
Apr. 23	6	16	22	100	94
Apr. 24	14	34	48	100	97
Apr. 25	7	26	33	100	92
Apr. 26	6	27	33	100	96
Apr. 27	4	20	24	100	100
Apr. 28	11	19	30	100	100
Apr. 29	7	9	16	100	100
Apr. 30	15	61	76	100	97
May 1	4	26	30	100	81
May 2	17	68	85	94	100
May 3	28	124	152	100	100
May 4	87	275	362	100	97
May 5	87	299	386	100	100
May 6	84	330	414		
May 7	14	88	102	86	100
May 8	85	387	472	98	100
May 9	65	486	551	98	99
May 10	116	409	525	100	100
May 11	66	389	455	95	98
May 12	118	536	654	98	100
May 13	144	1,051	1,195	100	100
May 14	255	1,381	1,636	97	99
May 15	328	2,107	2,435	100	100
May 16	333	1,871	2,204	94	100
May 17	257	1,264	1,521	100	95
May 18	125	744	869	100	100
May 19	59	509	568	100	100
May 20	192	1,327	1,519	99	100
May 21	303	1,917	2,220	99	100
May 22	296	1,647	1,943	100	100
May 23	132	739	871	100	100
May 24	80	440	520	100	100
May 25	102	338	440	100	100
May 26	91	424	515	100	100
May 27	86	379	465	100	98
May 28	137	436	573	100	100
May 29	64	164	228	100	98
May 30	24	88	112	96	100
May 31	18	47	65	89	100

Table 3. (cont.)

date	No. tagged and released			% tag retention	
	small	large	total	small	large
June 1	6	24	30	100	92
June 2	11	28	39	91	100
June 3	9	2	11		
June 4	9	24	33	100	96
June 5	7	11	18	100	100
June 6	3	8	11		
Totals	3,966	20,673	24,639	99	99

Table 4. Summary of Lachmach River coho smolt sampling data, spring, 1990.[a]

date	fork length (mm)			wet weight (g)		
	N	mean	SE	N	mean	SE
Method 1[b]						
Apr. 13	9	85.3	2.72	0		
Apr. 14	7	87.6	2.05	0		
Apr. 15	7	90.1	3.68	7	6.36	0.52
Apr. 16	10	91.3	4.47	10	6.94	0.87
Apr. 17	27	89.7	2.09	25	6.47	0.54
Apr. 18	16	84.1	1.79	16	5.50	0.34
Apr. 19	26	87.8	2.22	26	6.09	0.42
Apr. 20	22	86.8	1.95	22	5.86	0.37
Apr. 21	25	89.6	2.38	24	6.91	0.49
Apr. 22	50	85.6	1.41	50	5.67	0.26
Apr. 23	24	91.5	1.95	24	7.12	0.51
Apr. 24	53	92.2	1.93	51	8.40	1.00
Apr. 25	35	94.4	2.21	34	7.78	0.57
Apr. 26	34	96.5	3.46	34	9.39	1.83
Apr. 27	26	93.7	1.99	26	7.54	0.47
Apr. 28	30	91.2	2.18	30	7.13	0.55
Apr. 29	18	90.6	3.10	18	7.12	0.70
Apr. 30	82	94.6	1.45	82	7.95	0.34
May 1	37	92.5	1.91	37	7.46	0.48
May 2	88	93.7	1.13	86	7.86	0.29
May 3	100	93.8	0.95	98	7.47	0.25
May 4	100	92.7	0.92	100	7.32	0.23
May 5	100	93.4	1.00	100	7.54	0.23
May 6	100	95.7	1.06	100	8.00	0.27
May 7	107	96.9	1.05	0		
May 8	100	92.2	0.95	100	7.35	0.23
May 9	100	96.4	1.18	100	8.59	0.29
May 10	100	95.9	1.07	43	8.63	0.48
May 11	100	91.8	0.79	100	7.27	0.18
May 12	100	95.0	0.89	100	7.88	0.22
May 13	100	96.9	1.02	100	8.29	0.28
May 14	100	91.8	0.86	100	7.12	0.20
May 15	100	93.9	0.86	100	7.61	0.24
May 16	101	95.2	0.95	100	7.87	0.25
May 17	101	93.2	1.05	0		
Method 2						
May 17	109	95.0	0.85	26	8.91	0.50
May 18	100	94.8	0.92	100	8.75	0.97
May 19	100	95.3	0.98	100	7.88	0.25

Table 4. (cont)

date	fork length (mm)			wet weight (g)		
	N	mean	SE	N	mean	SE
----------Method 2----------						
May 20	100	94.8	0.99	100	7.90	0.25
May 21	100	91.2	0.84	100	7.01	0.19
May 22	100	95.7	0.98	100	7.99	0.26
May 23	100	92.7	0.87	100	7.48	0.23
May 24	100	91.5	0.71	100	7.01	0.16
May 25	100	93.0	0.83	100	7.31	0.20
May 26	100	90.5	0.72	100	6.82	0.17
May 27	100	91.4	0.79	100	7.00	0.20
May 28	100	91.5	0.79	100	7.04	0.17
May 29	100	91.0	0.71	100	7.00	0.16
May 30	100	92.2	0.83	100	7.22	0.20
----------Method 1----------						
May 31	73	90.6	1.04	72	7.09	0.29
June 1	32	89.9	1.63	32	6.75	0.35
June 2	40	89.8	1.52	4	7.17	0.74
June 3	39	88.3	1.70	39	6.58	0.38
June 4	37	90.1	2.21	37	7.34	0.68
June 5	20	89.9	2.55	20	7.12	0.66
June 6	11	92.0	2.81	11	7.52	0.77
Method 1	2,586	93.1	0.22	2,057	7.54	0.07
Method 2	1,409	92.9	0.23	1,326	7.44	0.09
Total	3,995	93.1	0.16	3,383	7.50	0.06

[a] Random samples were obtained in two ways. Method 1 involved selecting the first 100 fish that were dipnetted, Method 2 involved selecting fish from every third dipnet until 100 were obtained.

[b] Method 1 was used to select all fish from Apr. 13 until May 17 On May 17, 101 fish were selected using Method 1 and 109 fish were selected using Method 2. Method 2 was used to select fish from May 17 until May 30, after this time all fish were selected with Method 1.

Table 5. Summary of recaptures used to estimate fence efficiency at the Lachmach River, spring 1990

date	recaptures	
	lower caudal	upper/lower caudal
May 3	100 released	
May 4	2	
May 5	34	
May 6	24	
May 7	3	
May 8	2	
May 9	2	
May 10	2	
May 11	0	
May 12	0	
May 13	0	
May 14	0	100 released
May 15	1	26
May 16	2	18
May 17	3	8
May 18	0	6
May 19	0	4
May 20	0	10
May 21	4	11
May 22	1	7
May 23	1	1
May 24	0	1
May 25	0	0
May 26	0	0
May 27	1	0
May 28	0	0
May 29	1	1
Totals	83	93

Table 6. Coded wire tagging summary by tag code.

tag code	smolt size	tagging dates	total tagged and released	% tag retention
08/26/34	small	Apr. 18- May 14	1,294	98.1
08/27/07	small	May 15- June 6	2,672	99.2
08/26/30	large	Apr. 18- May 8	1,806	97.3
08/27/19	large	May 8- May 19	10,491	99.1
08/27/18	large	May 19- June 6	8,376	99.5
Totals			24,639	98.8

Table 7. Summary of marked smolts captured at the main fence, Lachmach River, 1990.

mark type[a]	location marked	total number marked	number captured	% recapture
right ventral	5000m pond	757	307	40.5
left ventral	3820m	696	112	16.1
right ventral/right maxillary	4500m	356	49	13.8
right ventral/left maxillary	500m	136	39	28.7
left ventral/right maxillary	2000m	224	24	10.7
left ventral/left maxillary	2600m	322	15	4.7
left maxillary[b]	camp fence	109	13	11.9
right maxillary	7000m	286	11	3.8
upper caudal[c]	5000m	259	133	51.3
old upper and lower caudal[d]			22	

[a] all fish except the upper caudal, left maxillary and old upper and lower caudal marked fish were marked in the late summer and early fall 1989.

[b] left maxillary clipped fish were marked at the camp fence from June 6 to June 16 in 1989.

[c] upper caudal marked fish were marked at the 5000m fence during the 1990 study period.

[d] old upper and lower caudal marked smolts were marked in various locations within the watershed to obtain local population estimates.

Table 8. Summary of Lachmach River coho smolt sampling data for each age, spring, 1990.

age	length (mm) N	%	avg.	S.E.	weight (g) N	avg.	S.E.
1	91	32.5	77.04	1.21	82	4.49	0.27
2	181	64.6	107.06	1.13	155	12.03	0.48
3	8	2.9	123.12	5.04	8	15.75	1.80
	280	100.0	97.49	1.18	250	9.55	0.43

Table 9. Comparison of aging methods.

		Otolith ages		
		1.0	2.0	3.0
Scale Ages	1.0	19	2	0
	2.0	0	36	1
	3.0	0	2	3

unageable samples = 16

		Fin Ages		
		1.0	2.0	3.0
Scale Ages	1.0	20	1	0
	2.0	0	38	0
	3.0	0	1	4

unageable samples = 15

		Fin Ages		
		1.0	2.0	3.0
Otolith Ages	1.0	19	0	0
	2.0	2	45	1
	3.0	0	1	4

unageable samples = 7

	scale/otolith	scale/fin	otolith/fin
agreement	58 (92.1%)	62 (96.9%)	68 (94.4%)
non agreement	5	2	4
total	63	64	72

Table 10. Daily captures of other species at the main fence, Lachmach River, 1990.

date	rainbow trout	dolly varden	Cottus sp.	cutthroat trout	coho fry[a]	pink fry[a]	adult steelhead[b] up	down
Apr. 13		5	28				2	
Apr. 14	1	4	24				4	
Apr. 15	2	1	50				3	
Apr. 16		1	36			1	1	
Apr. 17		1	28			7		
Apr. 18	1	4	29			2		
Apr. 19	2	5	37	1		1		
Apr. 20		3	35				2	
Apr. 21		13	21				4	
Apr. 22	3	18	26				1	
Apr. 23		35	1				30	
Apr. 24		6	19				20	
Apr. 25	1	3	24				15	
Apr. 26	2	9	40	1				
Apr. 27		9	26				15	
Apr. 28		4	25				20	
Apr. 29	1	3	27				8	
Apr. 30	5	32	53				20	
May 1		12	49	1			22	
May 2	3	35	50				20	
May 3		55	57				15	
May 4	9	99	56				25	
May 5	3	51	52	1			15	
May 6		23	15		3			
May 7		13	19					
May 8		14	24		3		4	
May 9	4	23	28				6	
May 10	1	12	31				2	
May 11		22	61				6	
May 12		28	41				3	
May 13	10	42	18				6	
May 14	12	95	49				3	
May 15	1	29	49				3	
May 16	9	61	12				3	
May 17	7	48	4				2	
May 18	8	66	10				6	
May 19	7	48	4				2	
May 20	18	104	8	1			6	
May 21	31	172	28				51	
May 22	26	103	15				6	
May 23	43	101	5				21	
May 24	14	23	17				2	
May 25	41	32	9				5	
May 26	63	51	19				2	
May 27	117	161	13				31	

Table 10. (cont.)

date	rainbow trout	dolly varden	Cottus sp.	cutthroat trout	coho fry	pink fry	adult up	steelhead down
May 28	74	97	17	1	7		6	
May 29	73	44	21		3			
May 30	39	14	8		3			
May 31	30	14	2				4	1
June 1	34	4	19					
June 2	38	9	8		1			
June 3	209	47	6				3	90
June 4	132	35	16	1				2
June 5	84	8	7	2				
June 6	34	5	12					
Totals	1189	1964	1387	9	20	11	334	93

[a] most coho and pink fry were able to swim through the fence screens and thus were not captured.

[b] the numbers of adult steelhead migrating both upstream and downstream are both minimum numbers. Migrants were able to pass undetected both before and after the fence was installed and during periods when fence panels were lifted to allow steelhead passage.

Table 11. Fork length (mm) sample sizes and summaries from species other than coho that were caught at the main fence, Lachmach River, 1990. Standard error is in parenthesis.

date	rainbow trout		dolly varden		*Cottus* sp.		cutthroat trout		pink salmon	
	N	f.l.	N	f.l.	N	f.l.	N	f.l.	N	f.l.
Apr. 13	0		5	291.8 (17.40)	28	108.4 (5.13)	0		0	
Apr. 14	1	103.0	4	260.2 (12.90)	24	115.9 (4.34)	0		0	
Apr. 15	2	180.5 (32.20)	1	229.0	50	118.6 (3.17)	0		0	
Apr. 16	0		1	217.0	36	116.6 (3.38)	0		1	37.0
Apr. 17	0		1	245.0	28	119.5 (3.76)	0		0	
Apr. 18	1	100.0	4	233.7 (39.60)	29	112.2 (4.43)	0		2	35.0 (1.41)
Apr. 19	2	91.0 (17.70)	5	277.2 (19.20)	37	114.2 (4.19)	1	405.0	1	37.0
Apr. 20	0		3	219.3 (6.60)	35	111.3 (3.17)	0		0	
Apr. 21	0		13	262.5 (10.20)	21	117.1 (4.99)	0		0	
Apr. 22	3	158.7	18	265.4 (9.15)	26	118.1 (4.69)	0		0	
Apr. 23	0		34	263.5 (6.97)	0		0		0	
Apr. 24	0		6	245.0 (17.50)	19	116.3 (5.52)	0		0	
Apr. 25	1	143.0	3	311.0 (6.94)	24	108.9 (4.12)	0		0	
Apr. 26	2	51.0	9	267.6 (27.10)	40	109.8 (4.27)	1	141.0	0	
Apr. 27	0		9	225.2 (22.50)	26	114.2 (6.78)	0		0	
Apr. 28	0		4	283.2 (14.70)	23	110.4 (3.96)	0		0	
Apr. 29	1	133.0	3	177.7 (15.40)	27	106.6 (4.71)	0		0	
Apr. 30	5	122.0	32	244.6 (8.64)	51	115.6 (2.78)	0		0	
May 1	0		12	259.6 (13.00)	49	114.3 (2.13)	1	318.0	0	
May 2	3	143.0 (7.12)	35	261.9 (9.47)	0		0		0	
May 3	0		42	236.4 (7.80)	38	115.1 (2.34)	0		0	
May 4	9	138.3 (7.41)	54	247.0 (6.86)	48	113.3 (2.66)	0		0	
May 5	3	110.7 (28.70)	47	226.2 (6.52)	52	115.4 (3.12)	1	381.0	0	
May 7	0		13	182.6 (19.45)	19	117.8 (6.48)	0		0	
May 8	0		14	176.8 (11.63)	24	105.2 (4.40)	0		0	
May 9	4	126.2 (16.60)	23	158.0 (10.28)	28	110.5 (4.74)	0		0	
May 10	1	98.0	12	162.7 (14.16)	31	112.2 (3.25)	0		0	
May 11	0		22	132.5 (6.04)	61	106.6 (2.34)	0		0	

Table 11. (cont.)

date	rainbow trout			dolly varden			*Cottus* sp.			cutthroat trout			pink salmon		
	N	f.l.		N	f.l.		N	f.l.		N	f.l.		N	f.l.	
May 12	0			28	159.1	(8.68)	41	110.2	(2.85)	0			0		
May 13	10	116.5	(10.30)	42	140.6	(5.99)	18	105.1	(3.79)	0			0		
May 16	9	156.8	(10.89)	61	141.4	(4.22)	12	97.3	(5.70)	0			0		
May 19	2	105.0	(4.95)	24	134.2	(3.39)	3	98.3	(10.43)	0			0		
May 20	18	171.4	(4.00)	0			0			1	78.0		0		
May 21	31	145.0	(6.61)	0			0			0			0		
May 23	37	133.3	(6.47)	47	129.1	(2.41)	1	175.0		0			0		
May 24	14	135.6	(9.43)	23	125.9	(4.76)	17	106.2	(5.17)	0			0		
May 25	41	142.3	(4.86)	32	124.1	(2.14)	9	112.7	(6.46)	0			0		
May 26	63	149.8	(4.05)	51	131.9	(2.83)	19	103.8	(3.99)	0			0		
May 28	54	143.5	(4.52)	64	130.5	(2.74)	7	117.4	(5.10)	1	220.0		0		
May 29	73	149.7	(3.20)	44	132.9	(2.70)	21	97.4	(3.58)	0			0		
May 30	39	145.4	(5.00)	14	129.6	(2.76)	8	101.2	(6.97)	0			0		
May 31	30	139.4	(5.92)	14	124.2	(3.80)	2	59.5	(1.06)	0			0		
June 1	34	156.5	(3.78)	4	140.7	(7.24)	19	107.5	(7.02)	0			0		
June 2	38	140.5	(5.14)	9	124.9	(3.13)	8	105.4	(7.12)	0			0		
June 3	89	147.1	(2.92)	36	137.4	(2.17)	5	98.4	(9.71)	0			0		
June 4	131	143.7	(2.47)	35	133.0	(2.56)	16	96.0	(5.36)	1	132.0		0		
June 5	84	151.6	(2.81)	8	125.1	(3.68)	6	115.8	(6.78)	2	133.5	(1.06)	0		
June 6	34	148.1	(5.22)	5	119.4	(10.96)	12	105.0	(6.07)	0			0		
Total	869			970			1,098			9			4		
Mean (SE)		145.2	(1.07)		177.0	(2.14)		111.3	(0.68)		215.8	(38.28)		36.0	(0.87)

Table 12. Wet weight (g) sample sizes and sampling summaries from species other than coho that were caught at the main fence, Lachmach River, 1990. Standard error is in parenthesis.

date	rainbow trout			dolly varden			Cottus sp.			cutthroat trout		pink salmon	
	N	mean w.w.		N	mean w.w.		N	mean w.w.		N	mean w.w.	N	mean w.w.
Apr. 13	0			0			0			0		0	
Apr. 14	0			0			0			0		0	
Apr. 15	2	65.2	(33.37)	1	96.8		50	24.7	(2.23)	0		0	
Apr. 16	0			1	82.4		36	22.3	(2.21)	0		1	0.25
Apr. 17	0			1	122.9		27	23.6	(2.88)	0		0	
Apr. 18	1	8.3		4	119.5	(32.44)	29	19.5	(2.09)	0		2	0.22(0.02)
Apr. 19	2	9.1	(4.43)	3	112.2	(11.30)	36	22.2	(3.16)	0		1	0.25
Apr. 20	0			3	82.0	(7.06)	35	18.4	(1.56)	0		0	
Apr. 21	0			10	117.6	(10.15)	21	23.6	(3.21)	0		0	
Apr. 22	3	39.0	(8.95)	14	125.8	(9.03)	26	23.7	(4.28)	0		0	
Apr. 23	0			26	118.5	(6.52)	0			0		0	
Apr. 24	0			5	93.2	(4.13)	19	23.7	(3.94)	0		0	
Apr. 25	1	19.2		0			24	19.8	(2.77)	0		0	
Apr. 26	1	1.2		4	58.2	(14.72)	40	21.4	(3.25)	0		0	
Apr. 27	0			6	65.3	(14.13)	24	23.6	(4.41)	0		0	
Apr. 28	0			2	125.3	(31.66)	23	18.9	(2.19)	0		0	
Apr. 29	1	19.8		3	45.5	(9.98)	27	17.9	(2.44)	0		0	
Apr. 30	5	15.9	(0.92)	24	93.3	(7.65)	51	22.7	(1.82)	0		0	
May 1	0			8	100.4	(11.38)	49	19.6	(1.26)	0		0	
May 2	3	26.1	(3.50)	26	106.2	(6.27)	0			0		0	
May 3	0			35	89.2	(7.38)	38	20.3	(1.35)	0		0	
May 4	9	24.6	(3.98)	42	93.0	(5.56)	17	21.5	(4.79)	0		0	
May 5	2	29.8	(16.45)	0			0			0		0	
May 7	0			0			0			0		0	
May 8	0			13	49.1	(8.17)	24	16.7	(2.24)	0		0	
May 9	0			13	56.4	(8.38)	10	21.4	(3.28)	0		0	
May 10	0			0			0			0		0	
May 11	0			22	20.9	(3.49)	61	15.6	(1.09)	0		0	

Table 12. (cont.)

date	rainbow trout			dolly varden			*Cottus* sp.			cutthroat trout			pink salmon		
	N	mean w.w.		N	mean w.w.		N	mean w.w.		N	mean w.w.		N	mean w.w.	
May 12	0			27	34.1	(5.05)	41	17.8	(1.84)	0			0		
May 13	10	16.6	(3.13)	42	25.4	(3.63)	18	14.8	(1.43)	0			0		
May 16	9	36.2	(6.59)	60	25.9	(2.61)	2	6.0	(2.12)	0			0		
May 19	2	10.1	(1.25)	24	19.3	(1.68)	3	12.5	(5.20)	0			0		
May 20	18	44.4	(3.32)	0			0			1	5.0		0		
May 21	31	30.2	(3.21)	0			0			0			0		
May 23	37	25.9	(2.90)	47	18.4	(1.01)	1	86.5		0			0		
May 24	14	25.2	(3.99)	23	17.3	(2.19)	1	80.6		0			0		
May 25	41	28.1	(2.35)	32	16.4	(0.72)	0			0			0		
May 26	61	31.1	(1.97)	51	19.5	(1.42)	0			0			0		
May 28	53	29.0	(2.05)	52	19.2	(1.50)	0			1	87.9		0		
May 29	72	30.8	(1.53)	44	19.9	(1.34)	0			0			0		
May 30	39	27.7	(2.01)	14	19.2	(1.42)	0			0			0		
May 31	30	26.6	(2.82)	14	16.6	(1.42)	0			0			0		
June 1	34	33.2	(1.87)	4	22.8	(2.63)	19	18.1	(5.14)	0			0		
June 2	0			0			0			0			0		
June 3	89	28.6	(1.34)	36	21.7	(1.09)	5	11.2	(2.70)	0			0		
June 4	130	26.9	(1.07)	35	20.1	(1.39)	16	10.3	(1.79)	1	19.5		0		
June 5	84	30.6	(1.27)	8	16.4	(1.43)	6	15.9	(2.80)	2	21.1	(0.67)	0		
June 6	34	29.6	(2.50)	5	15.4	(3.60)	12	12.8	(2.03)	0			0		
Total	818			784			791			5			4		
Mean (SE)		29.0	(1.02)		44.0	(1.57)		20.1	(0.72)		30.9	(13.83)		0.24	(0.12

Table 13. Daily captures of fish from the 2x3 inclined plane trap, Lachmach River, 1990.

date	coho smolts	coho fry	*Cottus* sp.	pink fry
Apr. 11	0	0	1	1,550
Apr. 12	2	0	2	325
Apr. 17	1	0	0	210
Apr. 18	2	0	0	250
Apr. 19	0	0	0	72
Apr. 20	0	0	0	230
Apr. 21	8	0	1	150
Apr. 25	2	0	0	49
Apr. 26	9	0	0	450
Apr. 28	4	0	1	107
Apr. 29	0	0	0	224
Apr. 30	0	0	0	634
May 1	0	0	0	230
May 2	0	0	0	410
May 4	0	0	0	67
May 6	0	0	0	18
May 9	15	0	2	8
May 11	147	0	0	0
May 12	239	0	0	0
May 13	109	0	4	0
May 14	226	0	5	0
May 20	31	0	1	0
May 21	170	1	2	5
May 22	177	0	2	0
May 23	15	0	1	4
June 2	0	4	0	0
June 3	0	8	0	0
June 4	0	1	0	0
June 5	0	7	0	0
June 7	0	5	1	0
June 8	0	6	0	0
Total	1,157	32	23	4,993

Table 14. Daily captures[a], fork lengths and standard errors of fish from the 5000 m fence, Lachmach River, 1990.

date	coho			rainbow trout		Dolly varden		cutthroat trout	
	N	f.l.	SE	N	f.l.	N	f.l	N	f.l.
Apr. 21	1	82.0		1	99.0	0		0	
Apr. 22	2	88.0	(6.36)	0		1	49.0	0	
Apr. 24	0			1	136.0	0		1	106.0
Apr. 26	1	72.0		0		0		0	
May 3	1	96.0		0		0		0	
May 4	4	92.0	(8.46)	0		0		0	
May 5	11	96.4	(2.24)	0		0		0	
May 6	2	93.0	(5.66)	0		0		0	
May 7	25	97.6	(2.32)	0		0		0	
May 9	1	97.0		0		0		0	
May 10	5	87.8	(3.01)	0		0		0	
May 12	2	88.0	(0.71)	0		0		0	
May 17	2	92.5	(3.18)	0		0		0	
May 19	27	87.9	(1.18)	0		0		0	
May 20	16	86.9	(1.26)	0		0		0	
May 21	94	90.2	(0.85)	0		0		0	
May 22	45	88.0	(1.06)	0		0		0	
May 23	4	96.2	(3.58)	0		0		0	
May 24	2	87.0	(0.00)	0		0		0	
May 25	4	94.0	(4.14)	0		0		0	
May 26	5	83.2	(2.10)	0		0		0	
May 27	1			0		0		0	
May 30	2	82.0	(0.00)	0		0		0	
June 3	1	113.0		0		1	81.0	1	126.0
June 7	2	80.0	(2.83)	1	102.0	0		0	
Total	259			3		2		2	
Mean (SE)		90.2	(0.55)		112.3(9.69)		65.0(11.31)		116.0 (7.07)

[a] A total of 9 coho, 3 rainbow trout, 1 Dolly varden and 1 cutthroat trout were captured but not sampled.

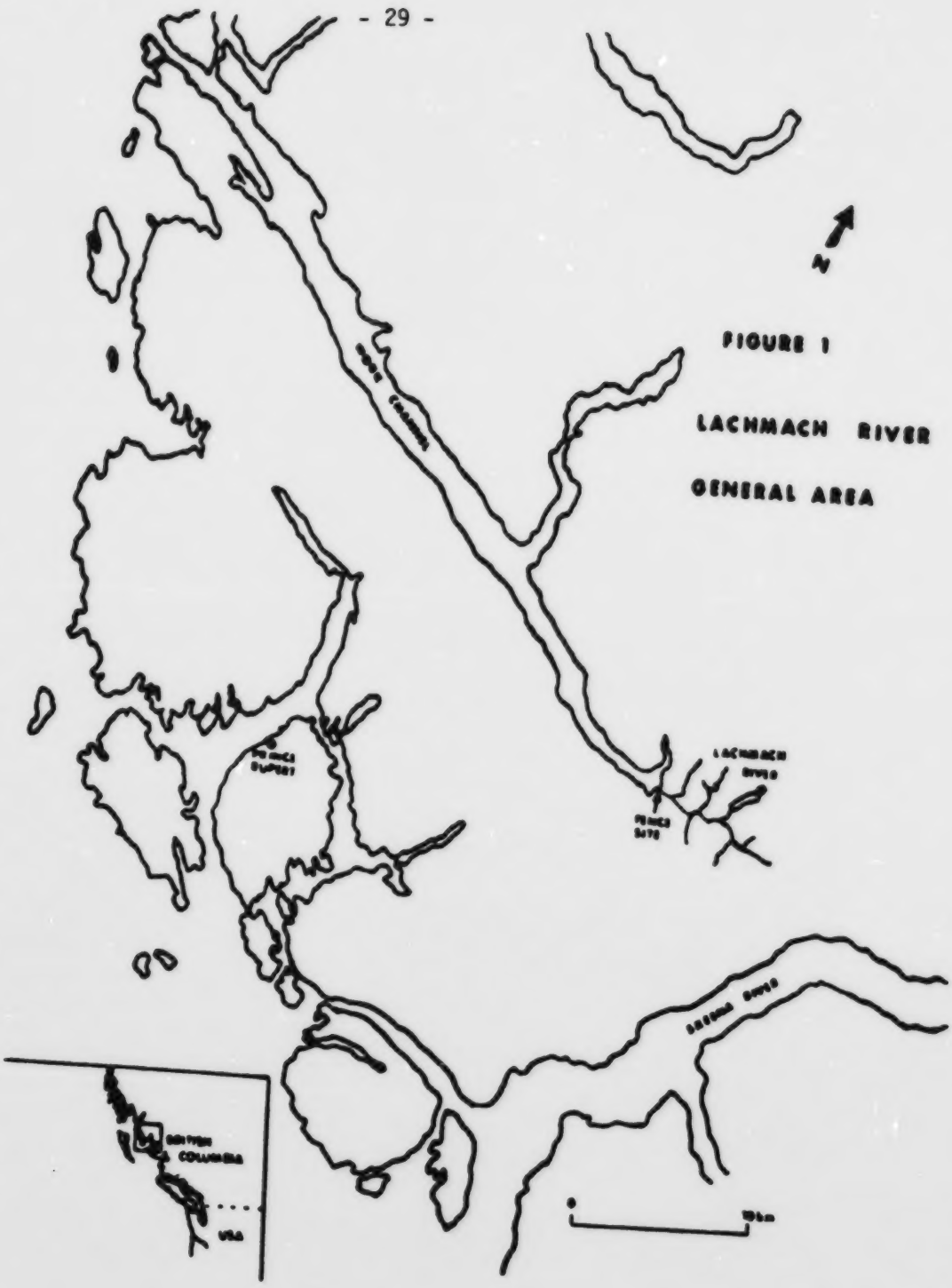


FIGURE 1

LACHMACH RIVER

GENERAL AREA

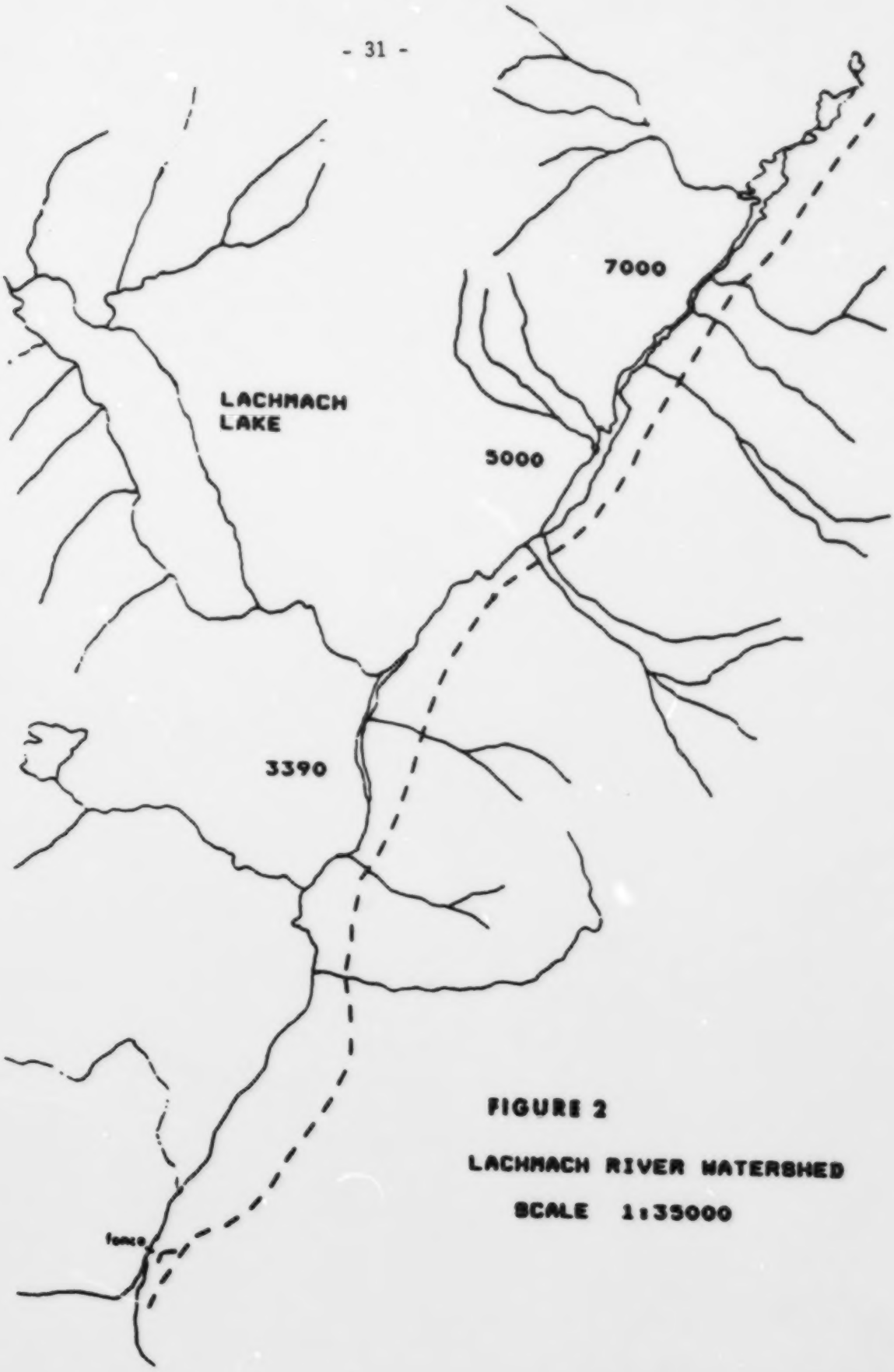


FIGURE 2

LACHMACH RIVER WATERSHED

SCALE 1:35000

Figure 3. Daily captures of coho smolts at the main fence, Lachmach River, 1990

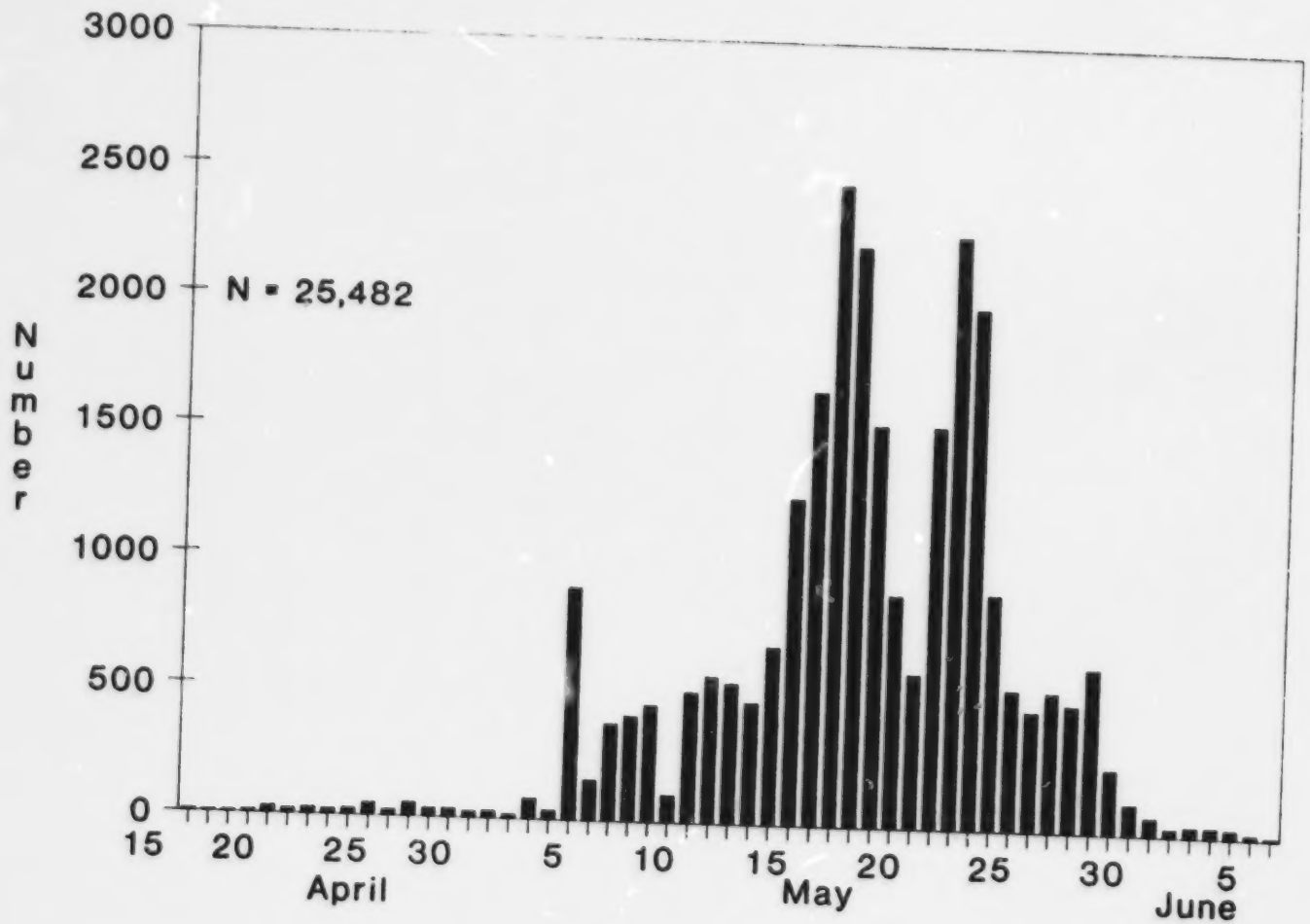


Figure 4. Length frequency of juvenile coho at the main fence, Lachmach River, 1990

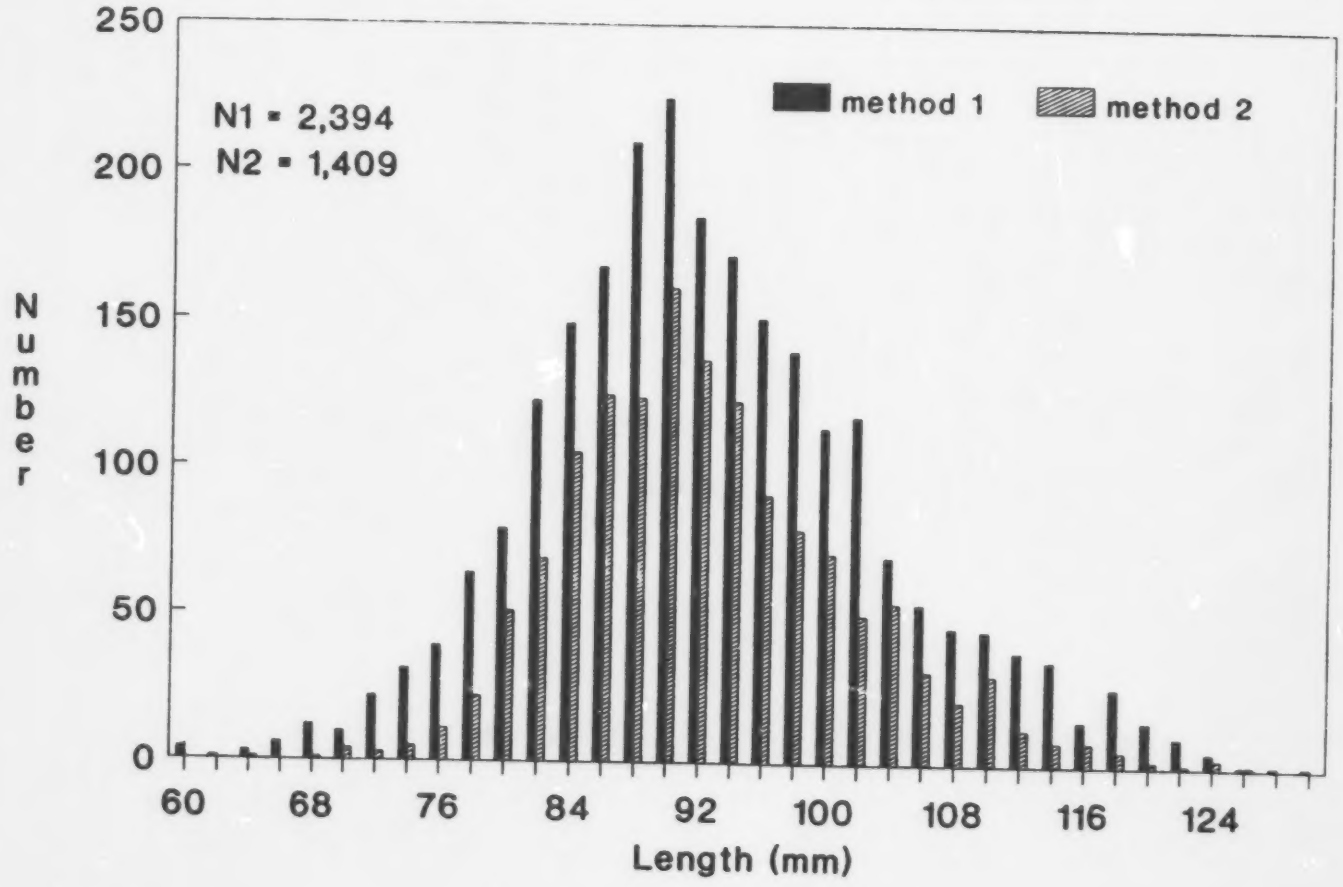


Figure 5. Length frequencies of coho smolts by age from the Lachmach River, 1990

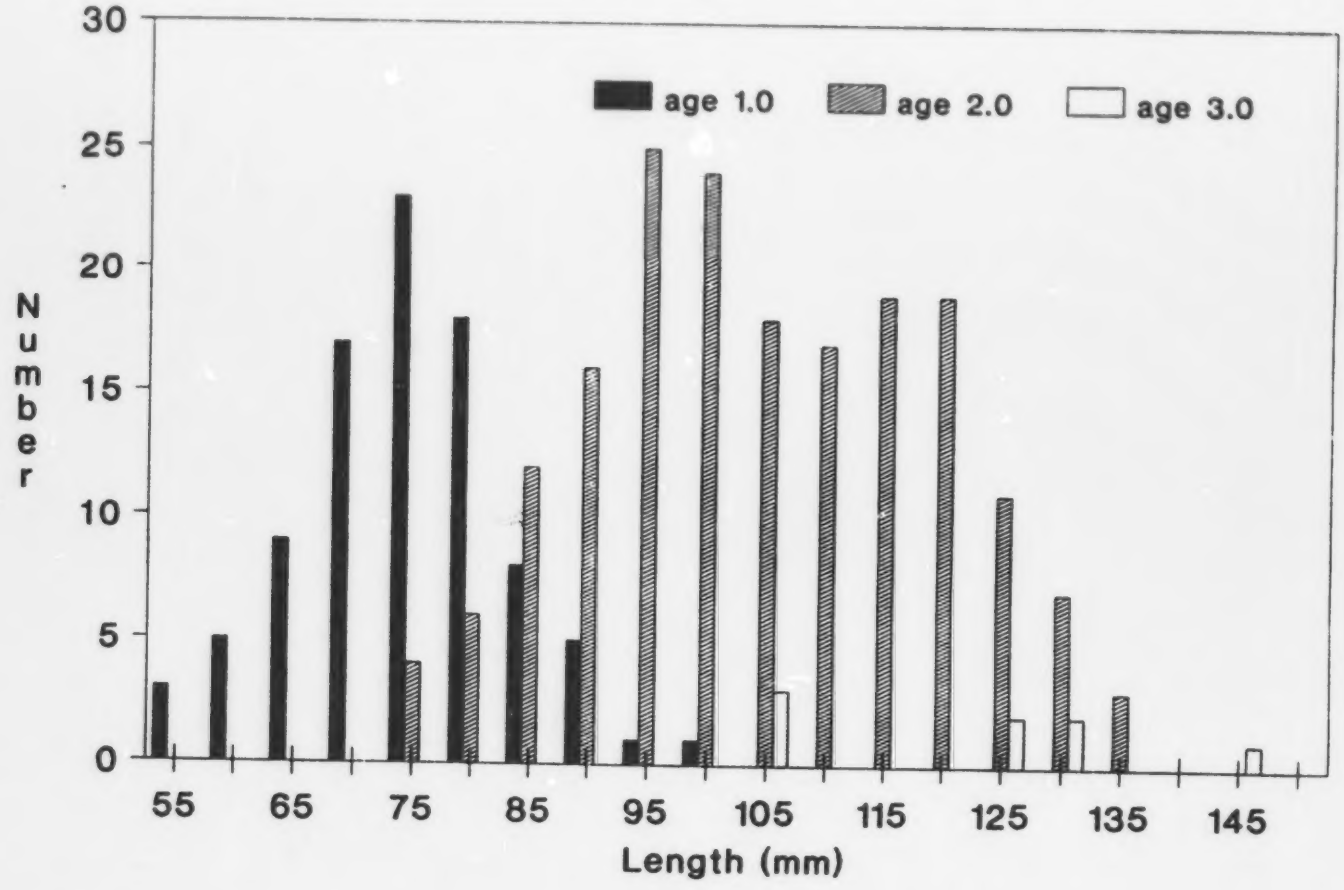


Figure 6. Weekly captures of species other than coho at the main fence, Lachmach River,1990

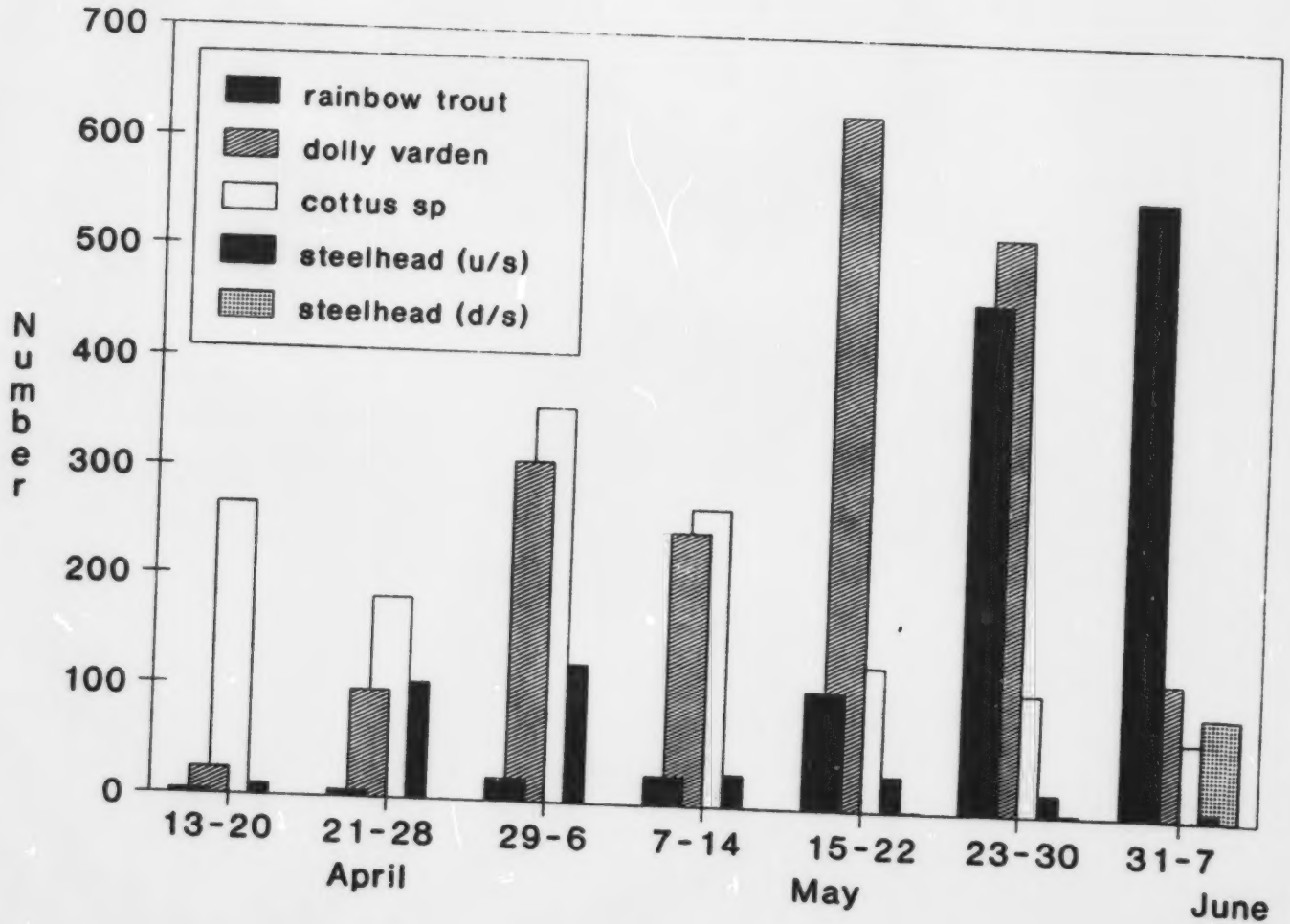


Figure 7. Length frequency of rainbow trout at the main fence, Lachmach River, 1990

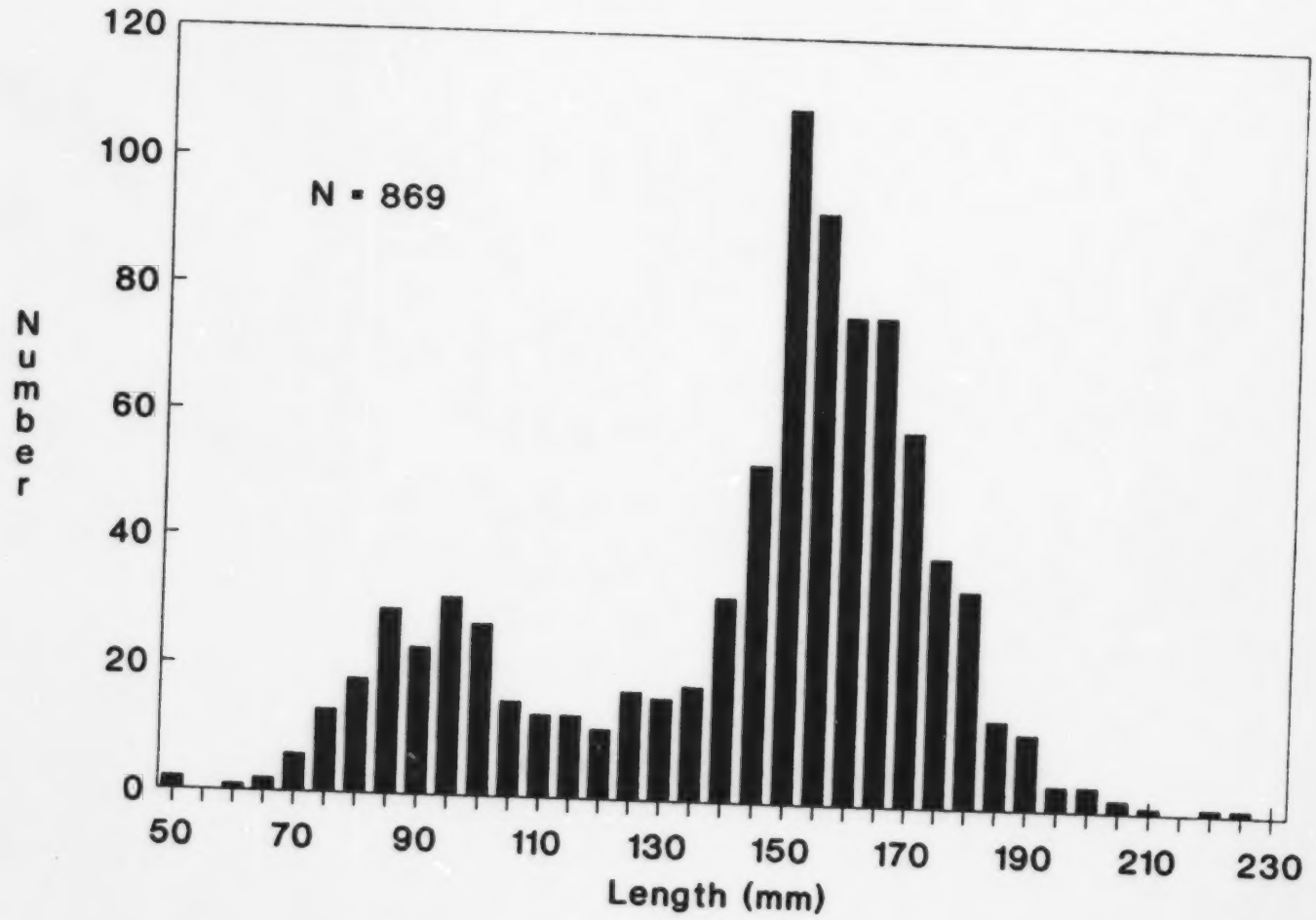


Figure 8. Length frequency of Dolly Varden at the main fence, Lachmach River, 1990

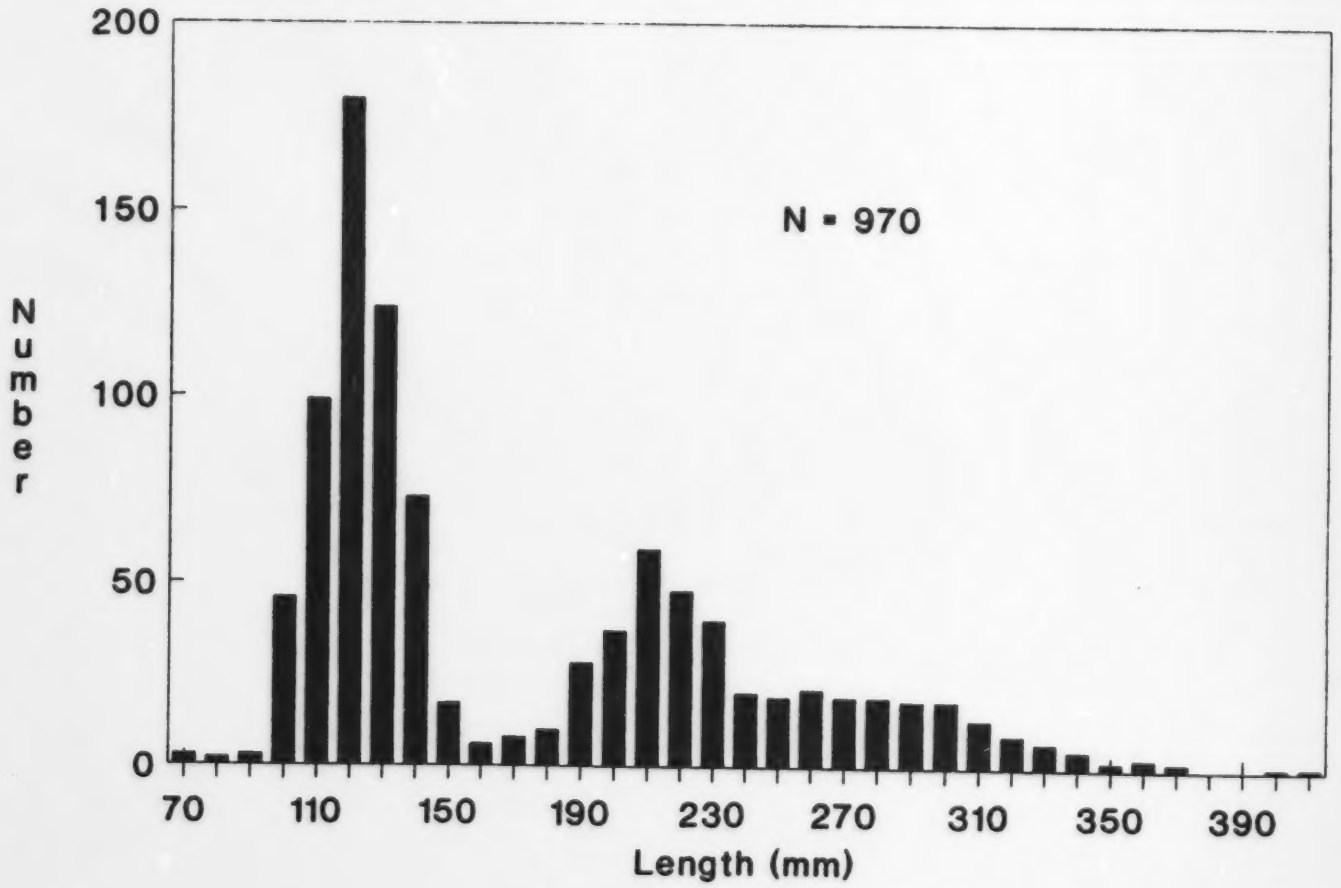
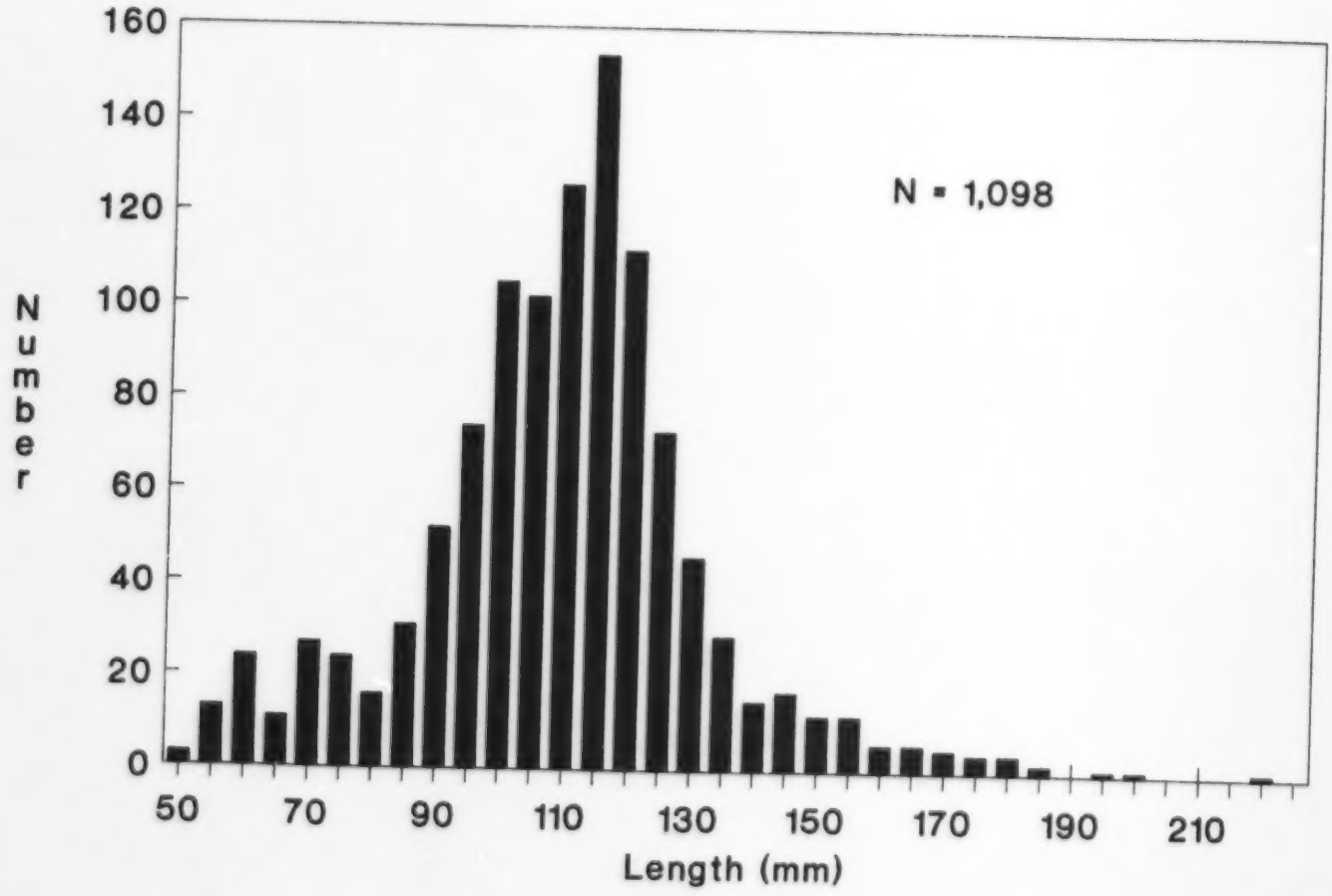


Figure 9. Length frequency of cottids
at the main fence, Lachmach River,1990



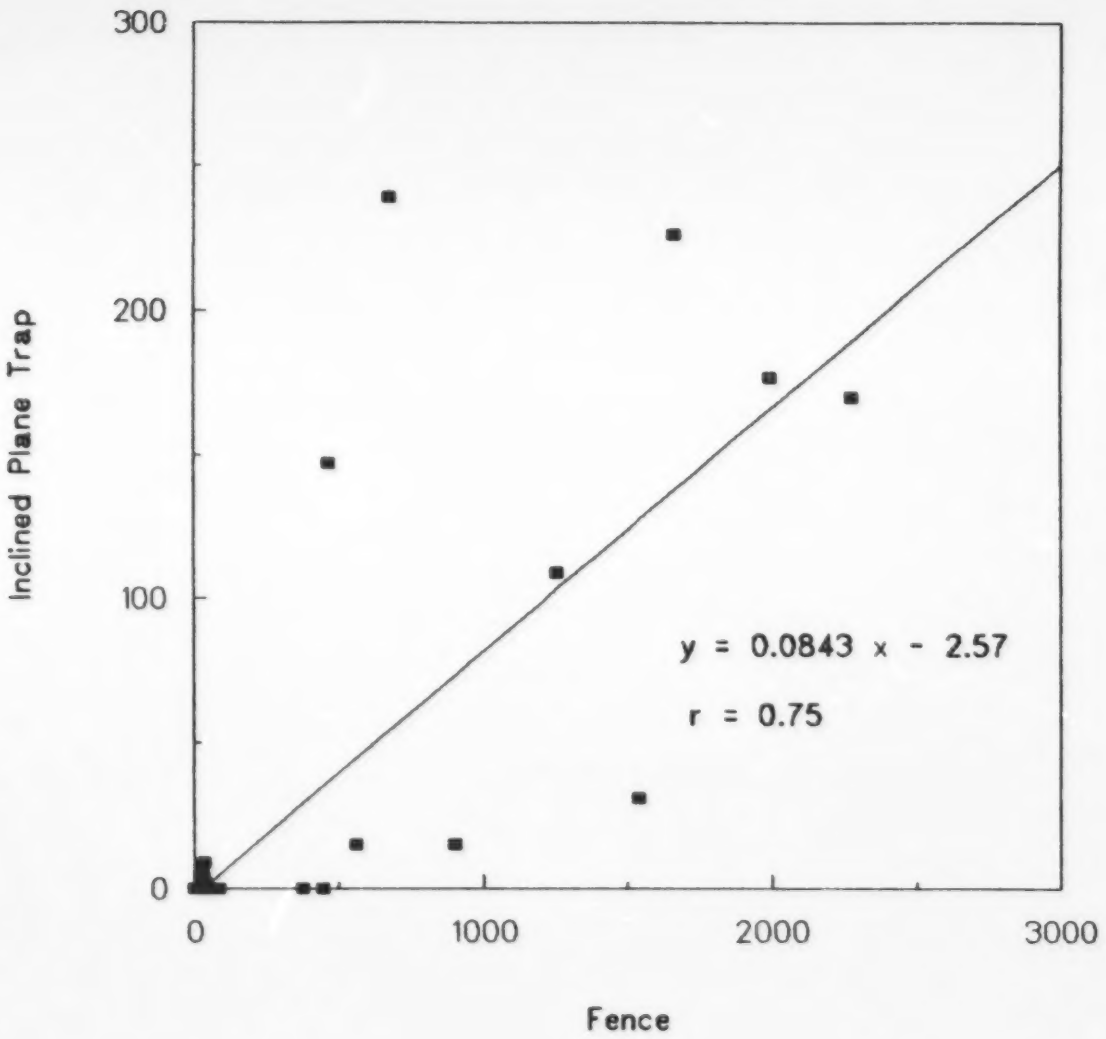


Figure 10. Regression of inclined plane trap and fence catches Lachmach River Spring 1990.

Figure 11. Precipitation at the main fence, Lachmach River, 1990

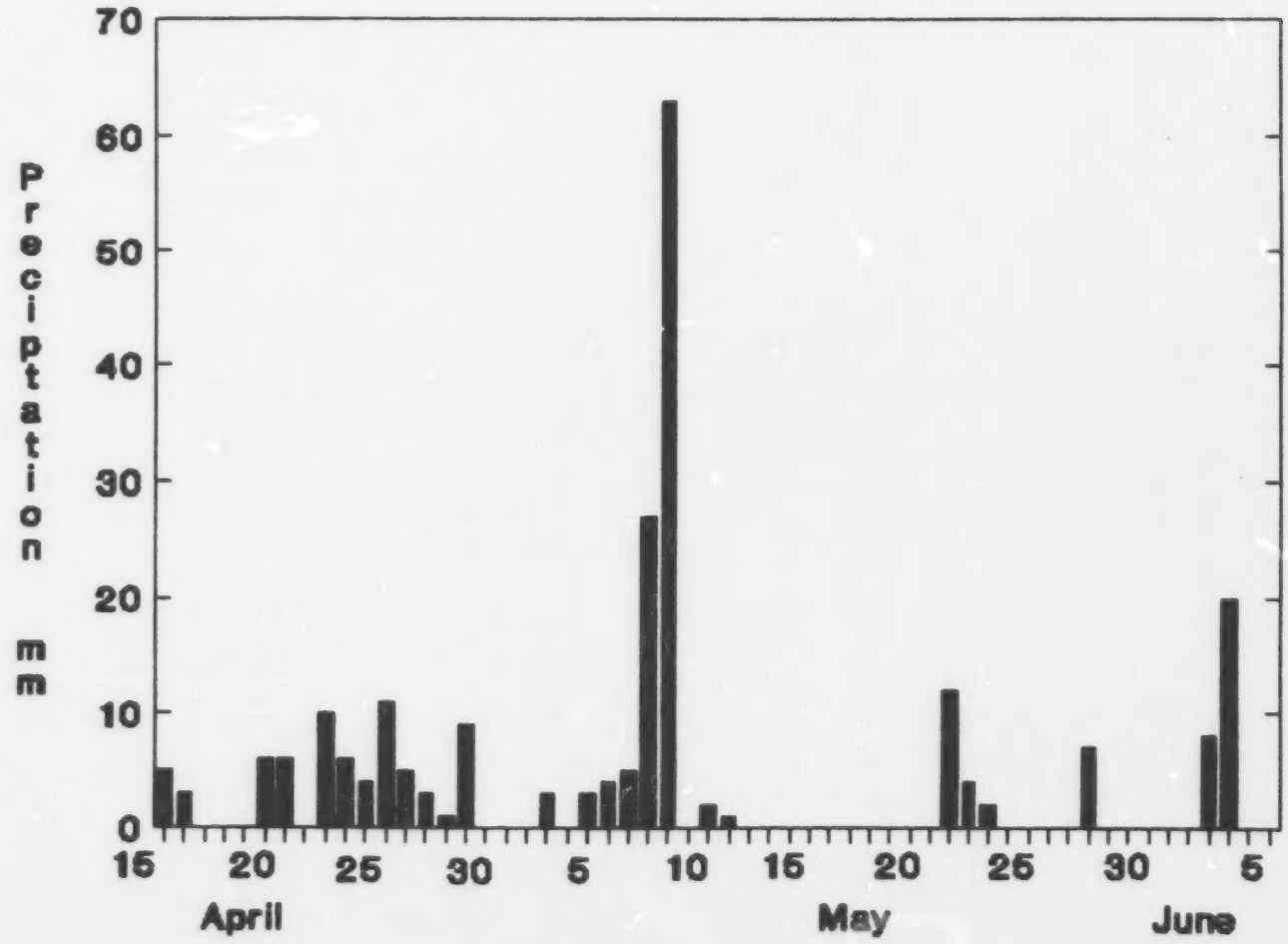


Figure 12. Maximum and minimum air temperatures at the main fence, Lachmach River, 1990

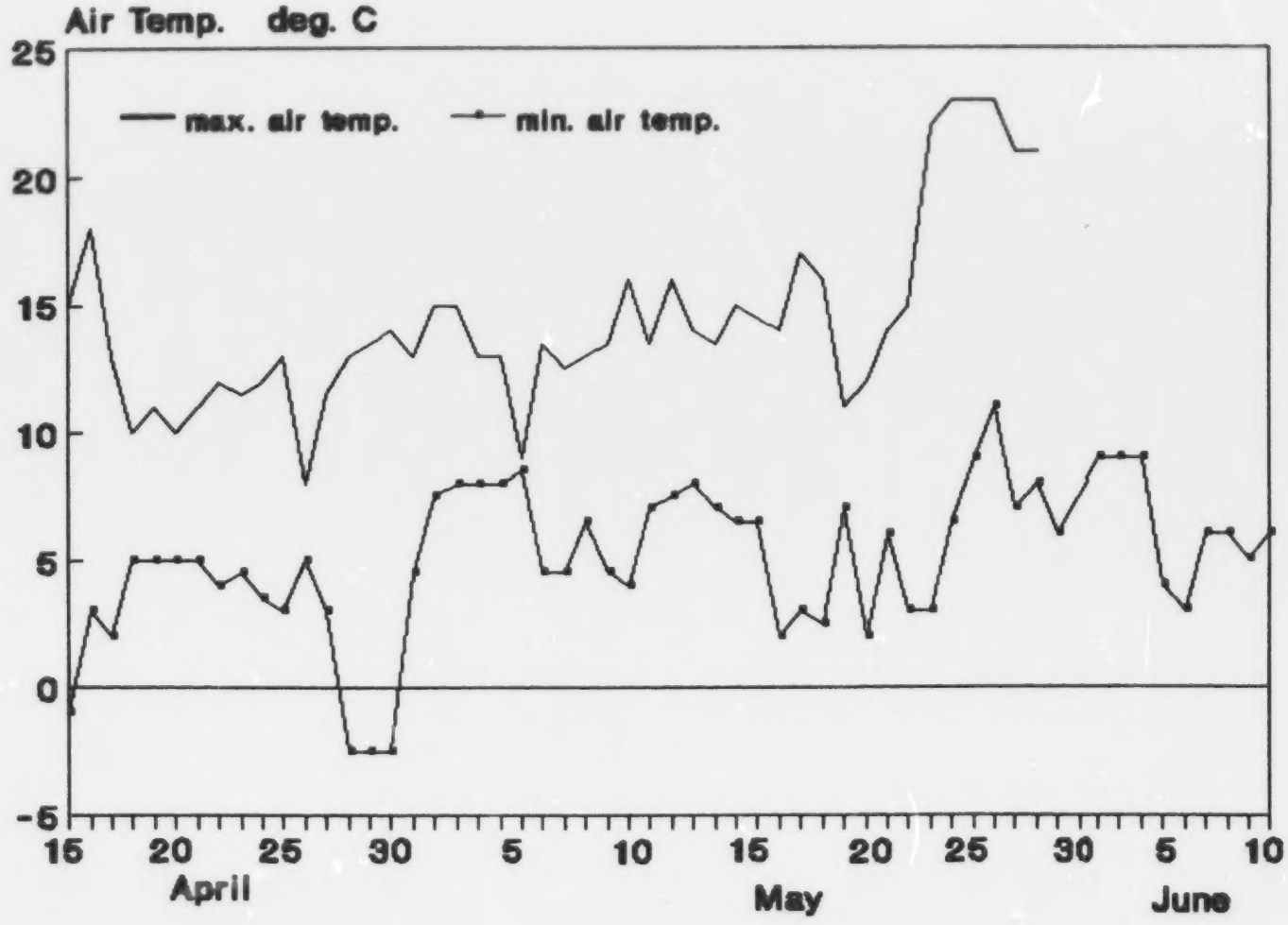


Figure 13. Water temperatures at the main fence, Lachmach River, 1990